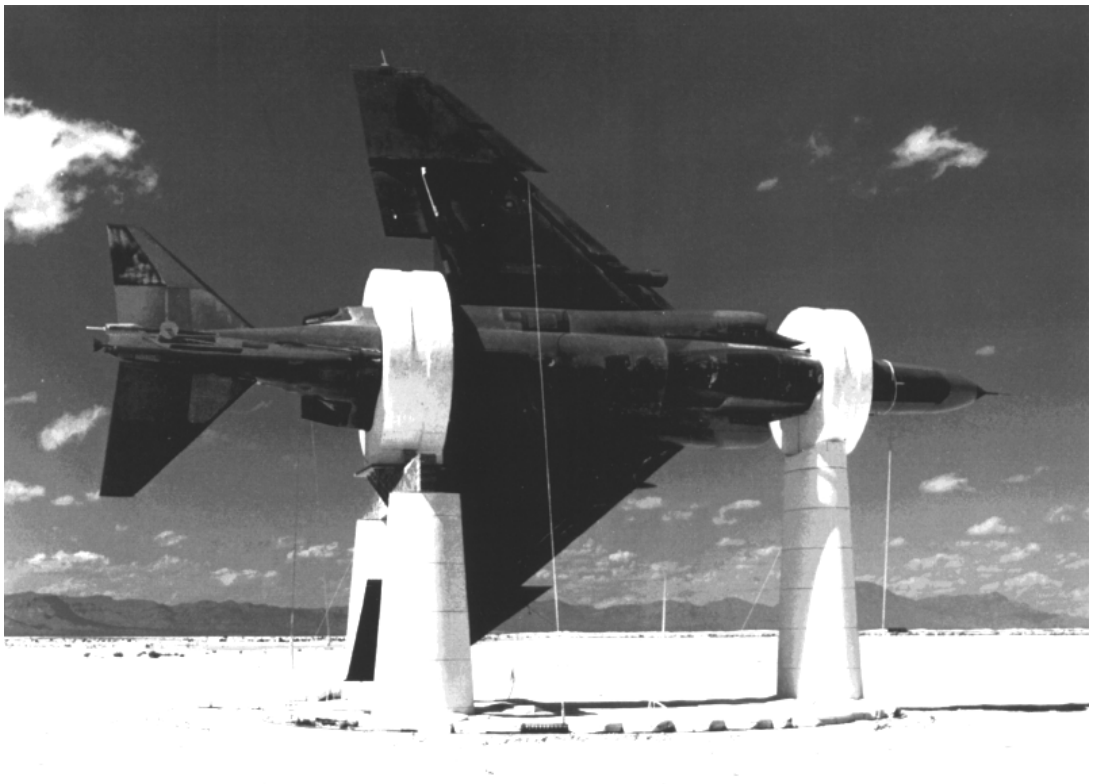
JOINT ELECTRONIC COMBAT TEST USING SIMULATION (JECSIM)



Joint Test and Evaluation Program		**Lead Service**
Authorized Manning	10	Navy
Total JT&E Budget	$27.8M	
Charter Date	3QFY96	
Completion Date	4QFY00	

JT&E DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010

Historically, electronic combat has made extensive use of simulation in the development and testing of new systems. It is becoming impractical to address all the needs of testing defensive countermeasures in open-air tests for reasons of complexity, safety, and security. As this trend continues, there is increased need for test and evaluation of the simulations themselves. The Joint Electronic Combat Test Using Simulation (JECSIM) Joint Test and Evaluation (JT&E) was chartered to begin this assessment. The joint test is to determine the full range of engagement features needed to assess both performance and model accuracy in selected semi-active missile engagements. This requires the use of laboratory tests, hardware-in-the-loop (HITL) facilities, captive carry tests, ground mounted seeker facilities, signature measurement, fuse testing, and full-up open air tests to address two issues:

1. The degree to which existing modeling and simulation (M&S) can be used to predict OT&E and DT&E results from semi-active missile engagements in ECM environments.

2. The sensitivity of probability of kill (Pk) calculations to changes in the end game geometry parameters predicted by M&S.

The tests are focused on the SA-6 semi-active missile system and the ALE-50 (towed decoy) and ALQ-165 (Advanced Self-Protect Jammer) ECM suites. The M&S to be tested focuses on Defense Intelligence Agency validated threat representations integrated into the Joint Model and Simulation System (JMASS) suite. In addition to addressing these issues of M&S prediction quality, the measurements have value in their own right for ongoing programs. This JT&E is designed to improve the test and evaluation of ECM systems, which are part of the effort to provide ***full- dimensional protection*** to our troops.

BACKGROUND INFORMATION

This effort grew out of longstanding difficulties with open-air range testing of ECM systems. By 1993, a Flyout Model Working Group was meeting to define a common model set. In 1994, discussions focused on active versus semi-active missiles for consideration. The feasibility study for JECSIM grew out of these efforts, leading to chartering in August 1996. Fuse testing and modeling, Pk sensitivity analysis, and other start-up activities were conducted in 1997.

Activities during 1998 included the first phase of measurements at the HITL facility, preparation of detailed test plans for the captive carry measurements, and the second phase of HITL measurements. A Technical Advisory Group was formed in summer 1998 to address analysis issues. The group performed a technical review of the methodology for using test data to correlate with digital models. In this context "correlate" has a specific meaning—referring to the degree to which a large number of missile flight parameters "correlate" between the test and the simulation.

TEST & EVALUATION ACTIVITY

During 1999, the final set of measurements using the ground-mounted SA-6 seeker were completed. There were many challenges in orchestrating the test program. However, M&S developments –the preparation of JMASS compliant threat models and the conversion to JMASS 98 for PCs–led to M&S complications causing more delays for JECSIM than from the physical measurement program.

Recently, with the threat models running in JMASS 98, more rapid progress is being made. JMASS 98 is much more efficient than earlier versions because it allows faster turnaround and greater ease of debugging modeling and data problems. The M&S work duplicating the lab and HITL measurements was completed at the end of FY99. HITL measurements and the related M&S work clearly demonstrated the impact of threat system variability (by serial number) on blue system performance. By "tail number" variability we mean the item-by-item difference in performance for a collection of systems of the same type. AFOTEC had previously demonstrated similar variability for a command guided missile in support of the ECM technique evaluation for the B-1B Defensive Systems Upgrade. These results conclusively establish the importance of requiring robust designs of Electronic Warfare systems rather than point solutions.

The modeling of the Captive Flight Test and the Ground Mounted Seeker Test are scheduled to be completed in 1QFY00. A utility analysis is underway to assess, somewhat subjectively, the utility of M&S in a

variety of regimes (from test planning thought test augmentations to system evaluation). If this can be made to work it will be a centerpiece of JECSIM accomplishments.

JECSIM developed a method and carried out an "extension analysis." This is a method for "extending" test results to different test conditions using validated M&S. The "extended" results are themselves quantitative predictions, with quantitative confidence measures for those predictions. The methodology is elaborate and its description is beyond the scope of this report. Nevertheless, it appears quite valuable in its intended use. In addition, it offers the possibility of using M&S to treat variability in threat systems (by serial number) to design robust Electronic Warfare solutions that are effective over the range of the variability.

TEST & EVALUATION ASSESSMENT

JMASS 98 promises to be a much more useful tool in T&E than earlier versions. Its use dramatically improved the JECSIM team's ability to execute M&S work.

JECSIM results conclusively demonstrate the need for robust Electronic Warfare designs based upon an informed assessment of threat system variability. Currently, existing M&S tools can be of great use here. Ideally, validated models based upon exploited systems would be used. However, with careful use, even models developed in the absence of fully exploited systems can support design and test of robust Electronic Warfare systems.

Developing the extension analysis was an ambitious undertaking that is showing considerable promise. *First*, it provides a methodology for using validated simulations of threat systems to be used to make quantitative predictions of blue jammer effectiveness against those systems accompanied by a quantitative confidence level. These predictions can be made outside the region where the simulation was validated, and the confidence level informs the user of the likely accuracy of the predictions, provided that the extension outside the measurement region does not sample untested features of either threat or EW system. This has been demonstrated for a few cases. It remains to be seen how universal the application will be. Perhaps a more important impact of the extension analysis will be in the area of variability. The extension analysis offers an approach to validating models and making predictions in cases where the serial number variability of the threat system leads to dramatic differences in system performance, especially at end game. Essentially, this methodology allows one to validate a system model against detailed test data when serial number variability leads to dramatic differences in field test outcomes. The validation comes with a confidence measure, which can be computed for any point in the operating space of the system. This is of tremendous potential value for designing robust systems.

CONCLUSIONS, RECOMMENDATIONS, LESSONS LEARNED

Modeling and Simulation can have great value when coupled with physical measurements as part of an integrated T&E program.

The difficulties encountered by JECSIM in comparing modeling and simulation and measurement results show that for optimal value M&S efforts must start early. Ideally, there would be an M&S infrastructure largely in place at the start of a measurement program. In the absence of this, it is probably easier to make the measurement than to simulate it.

The added value of M&S comes over the life of a program and is not primarily a short-term benefit.